Rewarding Learning

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Centres are responsible for their own hazard analysis and risk assessment before beginning this practical work with pupils.

Chemistry
Practical Manual

Content/Specification Section — Page

Practical C1

Determine the mass of water present in hydrated crystals

Introduction

Hydrated crystals contain water of crystallisation. **Water of crystallisation** is water which is chemically bonded into the crystal structure. When heated, hydrated crystals lose their water of crystallisation and become anhydrous. **Anhydrous** solids do not contain water of crystallisation and are powdery.

To determine the mass of water of crystallisation present in hydrated crystals the crystals can be heated gently to constant mass. To heat to constant mass:

- weigh the crystals and container
- heat for a few minutes, allow to cool then weigh
- repeat the heating and weighing until the mass does not change

An evaporating basin is most often used to heat the hydrated crystals, however for small masses a crucible may be used.

In this experiment you will determine the mass of water present in hydrated iron(II) sulfate crystals.

Apparatus and chemicals

- Hydrated iron(II) sulfate $FeSO_4.xH_2O$
- Spatula
- Bunsen burner, tripod and gauze
- Heatproof mat
- Evaporating basin
- Tongs
- Electronic balance
- Stopclock

Practical C1

Determine the mass of water present in hydrated crystals

Safety

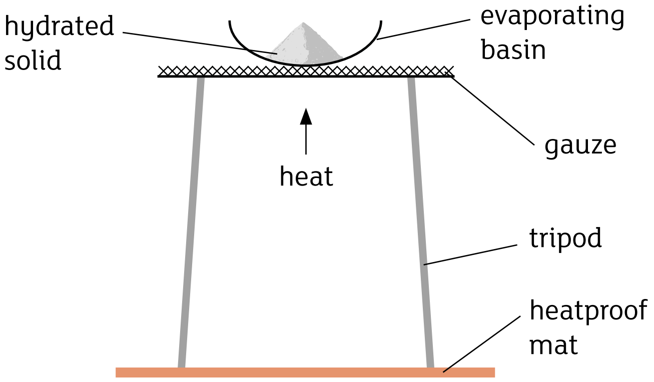
Wear safety goggles as the solid may spit when being heated.

Gentle heating should be carried out to reduce risk of spitting. Strong heating could cause $FeSO_4$ to decompose into iron(III) oxide and sulfur dioxide, so heat gently and use a well-ventilated lab.

Allow hot apparatus to cool before touching it, to reduce the risk of burns.

Iron(II) sulfate has a caution hazard symbol on the bottle. Wash hands if it touches your skin.

Diagram



Method

1. Weigh an evaporating basin and record this mass value in your results table to 2 decimal places.
2. Keep the evaporating basin on the balance and add between 1.50 g and 1.70 g of hydrated iron(II) sulfate crystals.
3. Record the mass of the evaporating basin and the crystals in your results table.
4. Place the evaporating basin containing the crystals on the gauze and heat gently for two minutes. You should heat gently to avoid decomposition and the formation of brown iron(III) oxide.
5. Allow to cool and reweigh the evaporating basin and its contents. Record the mass in your results table.
6. Heat the evaporating basin and its contents for a further two minutes, allow to cool, reweigh and record the mass in your results table.
7. Repeat step 6 until the mass readings are the same. You will now have heated to constant mass and all the water of crystallisation has been removed.

Practical C1

Determine the mass of water present in hydrated crystals

Results table

	Mass /g
Mass of evaporating basin	
Mass of evaporating basin and contents before heating	
Mass of evaporating basin and contents after heating for 2 minutes	
Mass of evaporating basin and contents after heating for 4 minutes	
Mass of evaporating basin and contents after heating for 6 minutes	
Mass of evaporating basin and contents after heating for 8 minutes	

Observations

Practical C1

Determine the mass of water present in hydrated crystals

Questions

1. Describe and explain what your results show.

2. Use your results to calculate:
   (a) The mass of hydrated iron(II) sulfate used.

   (b) The mass of anhydrous iron(II) sulfate produced.

   (c) The mass of water present in the hydrated iron(II) sulfate crystals.

   (d) Calculate the relative formula mass (RFM or M_r) of anhydrous $FeSO_4$.

   (e) Calculate the number of moles of anhydrous $FeSO_4$ produced.

   (f) Calculate the number of moles of water of crystallisation present in the hydrated iron(II) sulfate.

   (g) Use your results to parts (e) and (f) to determine the value of x in the formula $FeSO_4.xH_2O$. **(Higher only).**

3. The formula of hydrated iron(II) sulfate is $FeSO_4.7H_2O$. Suggest why a value obtained in this experiment would be:
   (a) Higher than 7.

   (b) Lower than 7.

Practical C2

Investigate the reactions of acids, including temperature changes that occur

Introduction

Acids react with metals, bases and carbonates to produce salts. In this practical you will record observations for these different reactions. In addition, you will record temperature changes which occur in some acid reactions, using a thermometer.

Some general observations which you may find are:

- bubbles indicating that a gas is produced
- the solid reactant disappearing and producing a solution
- a colour change for example copper(II) oxide is a black powder, and copper(II) carbonate is a green solid which react with acid to produce a blue copper(II) solution
- the test tube may feel warm due to heat released

Safety

Wear safety glasses and if a chemical touches your skin wash it off with water. Follow any other safety advice given by your teacher.

Experiment 1

Apparatus and Chemicals

- Boiling tube
- Boiling tube rack
- 25 cm^3 measuring cylinder
- Splint
- Bunsen burner
- Hydrochloric acid
- 2 cm strip of magnesium
- 2 cm piece of zinc
- 2 cm strip of copper

Practical C2

Investigate the reactions of acids, including temperature changes that occur

Method

1. Measure out 15 cm^3 of hydrochloric acid using a measuring cylinder and add to a boiling tube.
2. Add the magnesium strip to the boiling tube. Ensure that the magnesium is fully immersed in the acid by swirling and allow the reaction to proceed for about ten seconds.
3. Light a splint and hold the lit splint just above the mouth of the test tube containing the magnesium and acid.
4. Record all observations in the table below.
5. Repeat steps 1 and 2 using a piece of zinc. Record your observations.
6. Repeat steps 1 and 2 using a piece of copper. Record your observations.

Practical C2

Investigate the reactions of acids, including temperature changes that occur

Observations

Reaction	Observations
Hydrochloric acid + magnesium	
Hydrochloric acid + zinc	
Hydrochloric acid + copper	
Testing the gas with a lit splint	

Practical C2

Investigate the reactions of acids, including temperature changes that occur

Questions

1. In the reaction of magnesium and acid a gas is produced. Name the gas produced. Use results from your table to verify your answer.

2. Write a word equation for the reaction of zinc and hydrochloric acid.

3. Write a balanced symbol equation with state symbols for the reaction of magnesium and hydrochloric acid.

4. Write a balanced equation for the reaction occurs when the gas produced is tested with a lit splint.

5. From your results table name the least reactive metal.

Practical C2

Investigate the reactions of acids, including temperature changes that occur

Experiment 2

An acid will react with metal oxides. In this reaction, you will react sulfuric acid and copper(II) oxide.

Apparatus and Chemicals

- Kettle
- 250 cm^3 beaker
- 100 cm^3 beaker
- 25 cm^3 measuring cylinder
- Spatula
- Glass rod
- Heatproof mat
- Universal indicator paper
- Sulfuric acid
- Copper(II) oxide on a watch glass

Method

Record observations for steps 1, 6, and 8 in the table below.

1. Place a piece of universal indicator paper on a white tile and use a glass rod to add a drop of sulfuric acid onto the piece of universal indicator paper. Record the colour and pH.
2. Using a measuring cylinder, measure out 25 cm^3 of sulfuric acid into the small beaker.
3. Using hot water from a kettle, fill the 250 cm^3 beaker about 1/3 full with hot water.
4. Warm the sulfuric acid beaker by letting it rest (carefully) in the hot water bath (leave for 2 minutes).
5. Carefully remove the small beaker and add a spatula of copper(II) oxide to the acid slowly and stir with a glass rod.
6. Keep adding the copper(II) oxide, until there is some left over at the bottom of the beaker.
7. Let the beaker sit for 2 minutes to allow the black powder to settle.
8. Place a piece of universal indicator paper on a white tile and use a glass rod to add a drop of the solution from the medium beaker to the universal indicator paper. Record the colour and pH.

Practical C2

Investigate the reactions of acids, including temperature changes that occur

Test	Observation
1	
6	
8	

Questions

1. At the end of the experiment, you were asked to test the pH again – did you find that the pH is now higher? Why do you think this is?

2. Write the balanced symbol equation for the reaction between copper(II) oxide and sulfuric acid.

Practical C2

Investigate the reactions of acids, including temperature changes that occur

Experiment 3

An acid will usually release heat when it reacts.

In this experiment you are going to react an acid with an alkali and measure the temperature change during the reaction. The acid will react to produce a salt and water – no gas is produced.

Apparatus and Chemicals

- Polystyrene cup
- 250 cm^3 beaker
- Thermometer
- 25 cm^3 measuring cylinder
- Hydrochloric acid
- Sodium hydroxide solution
- Deionised water bottle

Method

1. Place the polystyrene cup into the 250 cm^3 beaker.
2. Using a measuring cylinder place 25 cm^3 of hydrochloric acid in the polystyrene cup.
3. Measure the initial temperature of the hydrochloric acid and record the result in the results table.
4. Rinse the measuring cylinder with deionised water and measure out 25 cm^3 of sodium hydroxide solution. Measure the temperature of the sodium hydroxide solution and record the result in the results table.
5. Add the sodium hydroxide solution to the acid, stir with the thermometer, measure and record the highest temperature reached during the reaction.

Initial temperature of acid / °C	Initial temperature of sodium hydroxide solution / °C	Average initial temperature / °C	Highest temperature reached / °C	Temperature change / °C

Practical C2

Investigate the reactions of acids, including temperature changes that occur

Questions

1. Why was a polystyrene cup used in this experiment?

2. Why was the polystyrene cup placed in a glass beaker?

3. Use your result to explain if this reaction is an exothermic or endothermic reaction.

4. Write an ionic equation for this neutralisation reaction. Include state symbols in your answer.

Practical C2

Investigate the reactions of acids, including temperature changes that occur

Experiment 4

In this reaction you will react calcium carbonate with hydrochloric acid and test the gas. Carbon dioxide gas is denser than air so it can be collected in and bubbled through the limewater.

Apparatus and Chemicals

- 25 cm^3 measuring cylinder
- 10 cm^3 measuring cylinder
- Boiling tube
- Test-tube
- Disposable pipette/dropper
- Test-tube rack
- Hydrochloric acid
- Calcium carbonate
- Limewater

Method

1. Measure 15 cm^3 of hydrochloric acid using the 25 cm^3 measuring cylinder and place into the boiling tube.
2. Measure 3 cm^3 of limewater using the 10 cm^3 measuring cylinder and place into a test-tube. Place the test-tube and boiling tube side by side in a rack.
3. Add the calcium carbonate to the acid.
4. Using the disposable pipette, collect the gas produced by opening and closing the dropper above the reaction in the boiling tube.
5. Once the gas has been collected in the disposable pipette, bubble the gas through the limewater and record your observations.

Practical C2

Investigate the reactions of acids, including temperature changes that occur

Observations

Questions

1. Write a balanced symbol equation for the reaction between the calcium carbonate and hydrochloric acid.

2. Write the equation for the reaction of carbon dioxide with limewater. Include state symbols.

Practical C3

Investigate the preparation of soluble salts

Experiment 1

Preparation of a soluble salt from an insoluble solid and acid.

In this experiment you will be making the salt copper(II) sulfate from copper(II) carbonate and sulfuric acid. The copper(II) carbonate is added slowly to the sulfuric acid until it is in excess. At this point the acid is neutralised, there are no more bubbles and the excess copper(II) carbonate is visible on the bottom. The excess copper(II) carbonate is filtered off leaving a solution of copper(II) sulfate.

Apparatus and Chemicals

- Copper(II) carbonate
- Sulfuric acid
- 2 × 100 cm^3 beakers
- Glass rod
- Tripod
- Gauze
- Bunsen burner
- Heat proof mat
- Filter funnel
- 3 × filter paper
- Conical flask
- Evaporating basin
- 25 cm^3 measuring cylinder
- Spatula

Safety

Wear safety glasses and if a chemical touches your skin wash it off with water. Follow any other safety advice given by your teacher.

Practical C3

Investigate the preparation of soluble salts

Method

Carry out the method recording your observations in the table below.

1. Measure out 25 cm^3 of sulfuric acid in a measuring cylinder and place in a conical flask.
2. Gently warm the acid and slowly add spatulas of copper(II) carbonate with stirring until there is excess copper(II) carbonate on the bottom of the conical flask.
3. Allow to cool and filter the mixture, collecting the filtrate in an evaporating basin.
4. Heat the filtrate in an evaporating basin on a tripod and gauze until the volume is about one half of what it was originally.
5. Leave the basin aside to allow the solution to cool and crystalise.
6. Filter off the crystals (if necessary).
7. Dry the crystals between two sheets of filter paper or in a desiccator or in a low temperature oven.

Appearance of copper(II) carbonate	
Appearance of sulfuric acid	
Observations in step 2	
Appearance of the residue	
Appearance of the filtrate	
Appearance of the crystals	

Practical C3

Investigate the preparation of soluble salts

Questions

1. Write a word equation for the preparation of the salt copper(II) sulfate in this practical.

2. Write a balanced symbol equation for the preparation of the salt copper(II) sulfate in this practical.

3. Draw a labelled diagram of the apparatus set up used in filtration in step 3.

4. Draw a labelled diagram of the apparatus set up used for evaporation in step 4.

Practical C3

Investigate the preparation of soluble salts

Experiment 2

Preparation of a soluble salt from an alkali and an acid.

Acids and alkalis are colourless solutions so an indicator must be used to determine when they are neutralised and a salt is produced. The general method involves measuring out the acid or alkali using a pipette, adding a few drops of indicator and adding the other solution from a burette until the indicator changes colour. Add charcoal, heat and filter to remove the charcoal and indicator or alternatively the volume should be recorded and the experiment repeated without the indicator, adding the recorded volume. In this practical you will prepare sodium chloride crystals from sodium hydroxide solution and hydrochloric acid.

Apparatus and Chemicals

- Burette, retort stand and clamp
- Pipette (25.0 cm^3) and safety pipette filler
- Conical flask
- Phenolphthalein indicator
- Hydrochloric acid
- Sodium hydroxide solution
- Decolourising charcoal (if following method 2)
- Evaporating basin
- Filter funnel and filter paper (3 pieces)
- Bunsen, tripod and gauze

Practical C3

Investigate the preparation of soluble salts

Method

Carry out the method recording your observations in the table below.

1. Fill the burette with hydrochloric acid.
2. Using the pipette and pipette filler, place 25.0 cm^3 of sodium hydroxide solution into a conical flask.
3. Add 3 drops of phenolphthalein indicator to the conical flask.
4. Add the hydrochloric acid from the burette into the conical flask, swirling gently until the colour of the indicator changes.
5. Record the volume of hydrochloric acid added, to 1 decimal place, in the table below.
6. Repeat steps 1 – 4 but this time without the indicator, adding the recorded volume of hydrochloric acid.
7. Pour the salt solution from the conical flask into an evaporating basin.
8. Place the evaporating basin onto a tripod and gauze and heat gently using a Bunsen burner until the volume of solution is reduced by half.
9. Allow the solution to cool and crystallise.
10. Filter off the crystals (if necessary).
11. Dry the crystals between two sheets of filter paper or in a low temperature oven or in a desiccator.

Initial burette reading /cm^3	
Final burette reading /cm^3	
Volume of acid used /cm^3	
Appearance of hydrochloric acid	
Appearance of sodium hydroxide solution	
Colour change of phenolphthalein at the end point	
Appearance of sodium chloride solution	
Appearance of sodium chloride crystals	

Practical C3

Investigate the preparation of soluble salts

Alternative method

Carry out steps 1 – 5 then use the following steps.

6. Add 2 spatulas of charcoal to the conical flask and heat gently on a tripod and gauze.
7. Allow to cool and filter the mixture, allowing the filtrate to collect in an evaporating basin then filter the mixture into an evaporating basin.
8. Place the evaporating basin onto a tripod and gauze and heat gently using a Bunsen burner until the volume of solution is reduced by half.
9. Allow the solution to cool and crystallise.
10. Filter off the crystals (if necessary).
11. Dry the crystals between two sheets of filter paper or in a low temperature oven or in a desiccator.

Appearance of charcoal	
Appearance of residue	
Appearance of filtrate	

Questions

1. Write a word equation for the preparation of the salt sodium chloride in this practical.

___

2. Write a balanced symbol equation, including state symbols for the preparation of the salt sodium chloride in this practical.

___

Practical C4

Identifying the ions in an ionic compound using chemical tests

Introduction

Ionic compounds contain positive ions and negative ions. Positive ions are called cations and negative ions are called anions. In this experiment you will carry out several tests to identify the cations and anions in ionic compounds.

Testing for Cations

There are 2 types of tests that can be used.

1. Flame Tests

Some positive ions produce an intense colour in a Bunsen burner flame which can be used to identify them.

Apparatus and materials

- Sodium chloride
- Calcium chloride
- Lithium chloride
- Potassium chloride
- Copper(II) chloride
- X and Y (unknown compounds)
- Concentrated hydrochloric acid
- Heatproof mat
- Nichrome wire

Safety

Follow safety advice given by teacher.

Practical C4

Identifying the ions in an ionic compound using chemical tests

Method

1. Take a piece of nichrome wire with a loop at one end.
2. Dip the loop in the concentrated hydrochloric acid and place in the blue flame of the Bunsen burner.
3. Repeat until the flame is no longer coloured, and the wire is clean i.e. impurities are removed.
4. Dip the clean nichrome wire in concentrated hydrochloric acid and then into the solid ionic compound.
5. Place the compound in the blue Bunsen burner flame and record the flame colour obtained.
6. Repeat for all the solid ionic compounds available, cleaning the wire loop each time.
7. Repeat the test for the unknown compounds labelled X and Y and identify the metal ions which they contain.

Table of Results

Compound	Flame colour	Cation present
Calcium chloride		
Copper(II) chloride		
Lithium chloride		
Potassium chloride		
Sodium chloride		
X		
Y		

Practical C4

Identifying the ions in an ionic compound using chemical tests

2. Precipitation tests to test for cations

When sodium hydroxide solution or ammonia solution are added to solution containing metal ions a precipitate (ppt) can form. A **precipitate** is a solid which may be formed on mixing two solutions. Sodium hydroxide solution and ammonia solution contain hydroxide ions and they react in this experiment with the metal cations to form metal hydroxides which are insoluble and so precipitates form.

Apparatus and Chemicals

- Copper(II) sulfate solution
- Iron(II) sulfate solution
- Iron(III) nitrate solution
- Aluminium nitrate solution
- Zinc nitrate solution
- Magnesium chloride solution
- Sodium hydroxide solution
- Ammonia solution
- Test tubes and stoppers × 6
- Test-tube rack
- 100 cm^3 beaker
- Disposable pipettes

Safety

Follow general safety advice of teacher.

Method

1. Using disposable pipettes add approximately 5 cm^3 of the metal ion solution to be tested to a test tube.
2. Add 1 cm^3 of sodium hydroxide solution from a disposable pipette, drop wise to the test tube.
3. Record your observations in the table.
4. Add a further 5 cm^3 (excess) sodium hydroxide drop wise to the test tube.
5. Stopper and shake the test tube.
6. Repeat for all of the metal ion solutions.

Practical C4

Identifying the ions in an ionic compound using chemical tests

Metal ion solution	Metal cation present	Effect of adding NaOH(aq)	Effect of adding excess NaOH(aq)
Aluminium nitrate			
Copper(II) sulfate			
Iron(II) sulfate			
Iron(III) nitrate			
Magnesium chloride			
Zinc nitrate			

7. Repeat steps 1 – 6 using ammonia solution instead of sodium hydroxide solution and record your results in the table below.

Metal ion solution	Metal cation present	Effect of adding NH_3(aq)	Effect of adding excess NH_3(aq)
Aluminium nitrate			
Copper(II) sulfate			
Iron(II) sulfate			
Iron(III) nitrate			
Magnesium chloride			
Zinc nitrate			

Practical C4

Identifying the ions in an ionic compound using chemical tests

Questions

1. Write down the formula of the metal ions which produce exactly the same results with excess sodium hydroxide solution and ammonia solution.

2. Write down the formula of the metal ions which form precipitates which dissolve on adding excess sodium hydroxide solution.

3. Write down the formula of the metal ions which form precipitates which dissolve on adding excess ammonia solution.

4. Can sodium hydroxide solution be used to determine if the cation present in a metal ion solution is aluminium or zinc? Explain your answer.

5. Explain why it is more suitable to use sodium hydroxide solution rather than ammonia solution to distinguish between a solution containing magnesium ions and a solution containing aluminium ions.

6. Write an ionic equation with state symbols, for the reaction which occurs when sodium hydroxide solution is added to a solution of iron(II) sulfate. **(Higher tier only).**

Practical C4

Identifying the ions in an ionic compound using chemical tests

Testing for Anions

In this section of the practical you will test for halide ions – anions formed from atoms of Group 7 elements (the halogens) and for sulfate ion and carbonate ion.

Test for sulfate ion

Apparatus and Chemicals

- Sodium sulfate solid
- Barium chloride solution
- Nitric Acid
- Limewater
- Test tubes
- Test tube rack
- Small beaker
- Disposable pipettes/droppers
- Spatula
- Glass rod

Safety

Wear safety glasses.

Follow general safety advice of teacher of all solutions – taking special care with barium chloride solution.

Practical C4

Identifying the ions in an ionic compound using chemical tests

To test for Sulfate Ions

1. Make a solution of sodium sulfate solution by dissolving one spatula measure of the solid in deionised water in a small beaker.
2. Add some sodium sulfate solution to a test tube until the tube is 1/3 full.
2. Using a disposable pipette add 2 cm^3 of barium chloride solution drop wise.
4. Record your observations in the table below.

Appearance of sodium sulfate solid	
Appearance of sodium sulfate solution	
Observation on adding barium chloride solution to sodium sulfate solution	

Questions

1. Write an ionic equation with state symbols for the reaction of barium chloride with sodium sulfate solution.

Practical C4

Identifying the ions in an ionic compound using chemical tests

To test for Halide Ions

Apparatus and chemicals

- Sodium chloride solution
- Potassium bromide solution
- Potassium iodide solution
- Silver nitrate solution
- Nitric Acid
- 3 × test tubes
- Test tube rack
- Disposable pipettes/droppers

Method

Read the method below and draw a table for your results in the space below the method.

1. Add each of the 3 solutions of sodium chloride, potassium bromide and potassium iodide to separate test tubes until the tubes are each 1/3 full.
2. Add four drops of nitric acid, shake gently.
3. Using a disposable pipette add 1 cm^3 of silver nitrate solution drop wise.
4. Record your observations in a table.

Questions

1. Write ionic equations, with state symbols, for the precipitation reactions which occur.

Practical C4

Identifying the ions in an ionic compound using chemical tests

To test for Carbonate Ions

Apparatus and Chemicals

- Sodium carbonate
- 100 cm^3 beaker
- Glass rod
- Spatula
- Limewater
- Hydrochloric acid solution
- 5 × test tubes
- Test-tube rack
- 2 × disposable pipettes

Method

1. Place 1 cm^3 of limewater in a test tube using a disposable pipette.
2. Place 1 spatula of sodium carbonate in a test tube.
3. Add 2cm3 of dilute hydrochloric acid to the sodium carbonate using a disposable pipette.
4. Collect any gas formed, this is easily done by opening and closing an empty disposable pipette/dropper above the reaction. The dropper contents are then bubbled through 1 cm^3 of limewater. Record all observations.

Observations of sodium carbonate and acid	
Observations in limewater test	

Questions

1. Identify the gas produced.

2. Write a balanced symbol equation for the reaction of sodium carbonate with hydrochloric acid.

Practical C5

Investigate the reactivity of metals

Introduction

Displacement reactions can be used to determine the reactivity of different metals. A displacement reaction is one in which a more reactive metal takes the place of a less reactive metal in a compound. In this practical a metal will be added to a solution of a different metal salt. If a reaction occurs the metal added is more reactive than the metal in solution. To determine if a reaction occurs you can note observations or measure the temperature change.

Apparatus and Chemicals

- Boiling tube rack
- Boiling tubes
- Copper(II) sulfate solution
- Magnesium sulfate solution
- Zinc sulfate solution
- Iron(II) sulfate solution
- Copper
- Zinc
- Iron
- Magnesium
- Stopclock

Safety

Wear safety goggles and follow the safety advice given by your teacher.

Method

1. Measure out 15cm^3 of copper(II) sulfate solution, zinc sulfate solution and iron (II) sulfate solution using a measuring cylinder and place each sample in a different boiling tube.
2. Add a piece of magnesium to each test tube.
3. Leave for 3 minutes.
4. Place a tick in the correct place in table 1 if a reaction occurred. Record all observations in table 2.
5. Repeat steps 1 – 4 using copper(II) sulfate solution, magnesium sulfate solution and iron(II) sulfate solution and zinc metal.
6. Repeat steps 1 – 4 using copper(II) sulfate solution, magnesium sulfate solution and zinc sulfate solution and iron metal.
7. Repeat step 1 – 4 zinc sulfate solution, magnesium sulfate solution and iron(II) sulfate solution and copper metal.

Practical C5

Investigate the reactivity of metals

Results

Table 1

	Copper	Magnesium	Iron	Zinc
Copper(II) sulfate		✓		
Magnesium sulfate				
Iron(II) sulfate				
Zinc sulfate				

Table 2: Observations

	Copper	Magnesium	Iron	Zinc
Copper(II) sulfate				
Magnesium sulfate				
Iron(II) sulfate				
Zinc sulfate				

Practical C5

Investigate the reactivity of metals

Questions

1. Use the results of your experiment to place the four metals in order from most to least reactive.

2. Explain why a reaction occurred between magnesium and copper(II) sulfate.

3. Write a balanced symbol equation for the reaction between magnesium and copper(II) sulfate.

4. Write an ionic equation for the reaction between magnesium and copper(II) sulfate.

5. Explain what happens to the magnesium, in terms of electrons, in this reaction.

6. Describe how you could practically determine the reactivity of magnesium compared to copper, zinc and iron, using the apparatus and chemicals given in this practical and a thermometer.

Practical C6

Investigate how changing a variable changes the rate of reaction

Introduction

Rate of a reaction is a measure of the speed of a chemical reaction and can be calculated from a time using the expression rate = $\frac{1}{\text{time}}$

The time may be for the rection to finish, as in this experiment, and can be determined by timing from the start of the reaction until there is no more fizzing and the solid reactant disappears.

Different variables such as temperature, concentration and surface area can change the rate of reaction. In this experiment you will investigate the effect of changing the concentration of hydrochloric acid on the rate of the reaction between magnesium and hydrochloric acid. The controlled variables, which need to be kept the same in the experiment include the volume of solution, the same mass and particle size of magnesium and the same temperature.

Safety

Wear safety glasses.

Follow safety advice given by your teacher.

Apparatus and Chemicals

- Hydrochloric acid
- 10 × 3 cm strips of magnesium
- 100 cm^3 beaker
- 250 cm^3 beaker
- Deionised water bottle
- 2 × measuring cylinders (25 cm^3 and 10 cm^3)
- Stop clock

Practical C6

Investigate how changing a variable changes the rate of reaction

Method 1

1. Using the measuring cylinder, measure out 25 cm^3 of hydrochloric acid and add to the small beaker.
2. Drop the piece of magnesium ribbon into the beaker and start the stopclock, swirl once to ensure the magnesium is fully coated in the acid.
3. Stop the stopclock when all the magnesium disappears. Record the time in seconds in the results table.
4. Repeat the experiment to ensure reliability and average the results.
5. Repeat steps 2 – 4 using a total of five different volumes of acid and deionised water to ensure different concentrations of acid. Use the most appropriate size of measuring cylinder and for each measurement and rinse with deionised water between uses.
6. Calculate the rate and record your results in the table.

Volume of hydrochloric acid /cm^3	Volume of deionised water /cm^3	Concentration of hydrochloric acid /mol/dm^3	Time taken for magnesium to disappear /s	Repeat time taken for magnesium to disappear /s	Average time /s	Rate /s^{-1}
25	0	2.0				
10	5	1.6				
15	10	1.2				
10	15	0.8				
5	20	0.4				

Practical C6

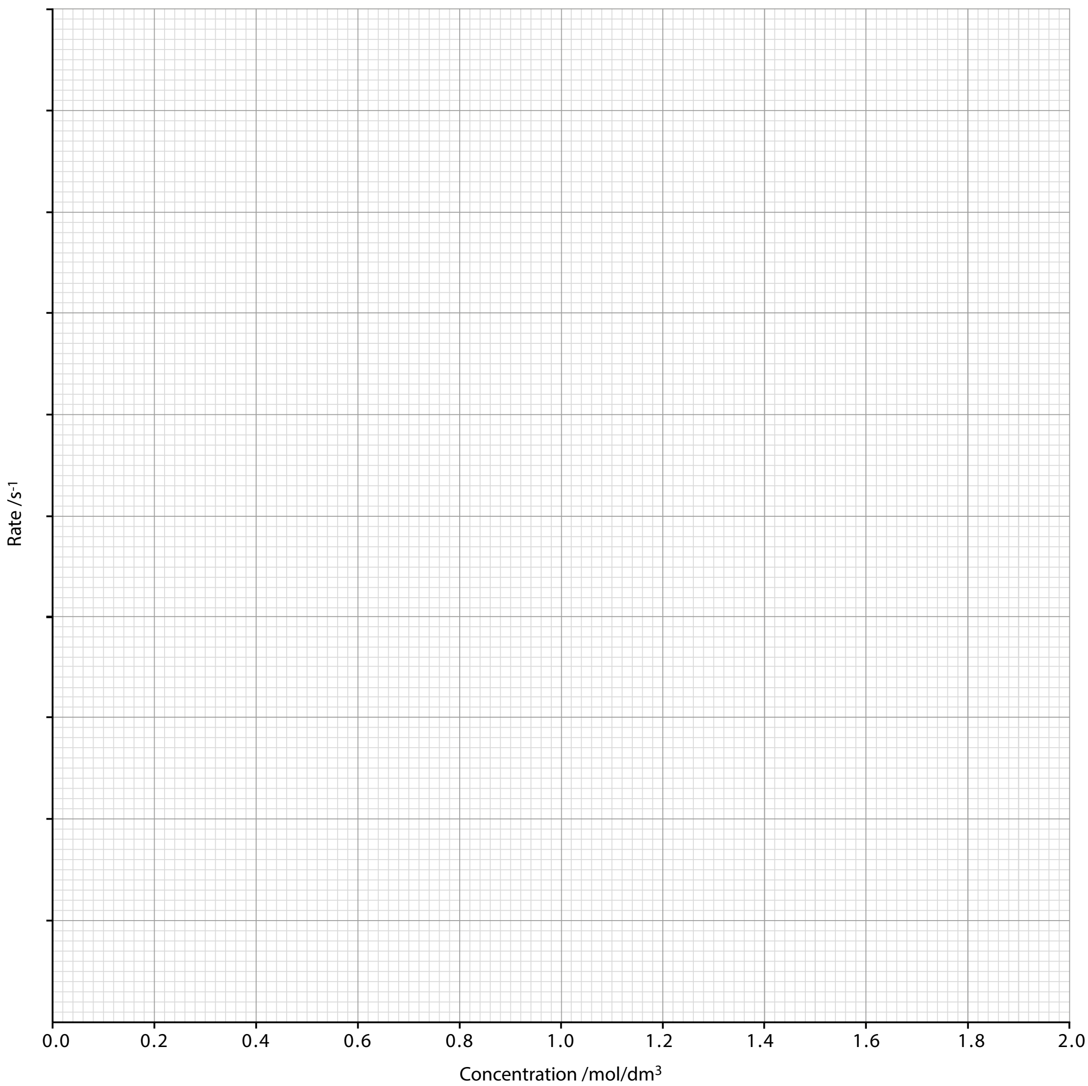
Investigate how changing a variable changes the rate of reaction

Questions

1. State the trend in your results.

___

2. Plot a graph of rate against concentration on the axes below. State the trend shown by the graph.



Trend: ___

Practical C7

Investigate the reactions of carboxylic acids

Introduction

Carboxylic acids have the carboxyl, -COOH functional group. They are weak acids as they are only partially ionised in water. Carboxylic acids react with bases, metals and carbonates forming salts, for example ethanoic acid forms ethanoate salts.

base + acid → salt + water

carbonate + acid → salt + water + carbon dioxide

metal + acid → salt + hydrogen

In this practical you will compare the reactions of ethanoic acid and hydrochloric acid.

Experiment 1: Comparing pH

Apparatus and Chemicals

- Universal indicator paper
- Ethanoic acid
- Hydrochloric acid
- White tile
- Glass rod
- Deionised water bottle

Method

1. Place two pieces of universal Indicator paper onto a white tile and using a glass rod place one drop of ethanoic acid onto one of the pieces of universal indicator paper.
2. Rinse the glass rod with deionised water and use it to place a drop of hydrochloric acid onto the second piece of universal indicator paper.
3. Record the colour of each piece of universal indicator paper and use the pH colour chart to determine and record the pH of the ethanoic acid and of the hydrochloric acid in the table below.

Acid	Colour of universal indicator paper	pH
Ethanoic acid		
Hydrochloric acid		

Practical C7

Investigate the reactions of carboxylic acids

Questions

1. Use your results to explain if each acid is strong or weak.

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2. Describe how you might improve the accuracy of this experiment.

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Experiment 2: Comparison of the reaction of magnesium with both acids

Apparatus and Chemicals

- Test tube
- Test tube rack
- 10 cm^3 measuring cylinder
- Wooden splint
- Hydrochloric acid
- Ethanoic acid
- 2 × 1 cm strips of magnesium ribbon
- Deionised water bottle

Method

1. Using a measuring cylinder measure out 10 cm^3 of ethanoic acid and place in a test tube.
2. Add a 1 cm strip of magnesium, swirl and record all observations in the table below.
3. Using a measuring cylinder measure out 10 cm^3 of hydrochloric acid and place in a test tube.
4. Add a 1 cm strip of magnesium metal, swirl and test the gas produced with a lighted splint. Record all your observations in the table below.

Practical C7

Investigate the reactions of carboxylic acids

Reaction	Observations
Ethanoic acid + magnesium	
Hydrochloric acid + magnesium	
Test with lighted splint	

Questions

1. State two ways in which you know a gas was produced in the reaction of magnesium and hydrochloric acid.

2. Write a word and balanced symbol equation for the following reactions.
   (a) Ethanoic acid + magnesium

   (b) Hydrochloric acid + magnesium

Practical C7

Investigate the reactions of carboxylic acids

Experiment 3 Comparing the reaction of calcium with both acids

Apparatus and chemicals

- 2 pieces of calcium
- Hydrochloric acid
- Ethanoic acid
- 2 × 100 cm^3 beakers
- Stopclock
- Tweezers
- 25 cm^3 measuring cylinder

Method

Before beginning this practical, read the method and draw a suitable table for your results in the space below the method.

1. Using a 25 cm^3 measuring cylinder place 20 cm^3 of hydrochloric acid into a small beaker.
2. Using tweezers add one piece of calcium to the beaker and immediately start a stop clock.
3. Stop the clock and Record the time in seconds when the calcium has completely disappeared.
4. Repeat steps 1 – 3 using ethanoic acid instead of hydrochloric acid.

Table

Practical C7

Investigate the reactions of carboxylic acids

Questions

1. Using your results state and explain which reaction was faster.

2. Write a balanced symbol equation for ethanoic acid and calcium.

Practical C8

Determining the reacting volumes of solutions of acid and alkali by titration and determine the concentration of solutions of acid and alkali by titration

Introduction

A titration is a very accurate experimental technique used to determine the volume of solutions, usually acid and alkali, which react together. This information can be used to determine the concentration of a solution.

In this experiment you will titrate sodium hydroxide solution with hydrochloric acid. You will place a 25.0 cm^3 sample of sodium hydroxide in a conical using a pipette, add a few drops of phenolphthalein indicator and add the hydrochloric acid with swirling until the indicator changes colour. A rough titration gives an idea of the end point and the titration should be repeated to obtain two accurate titration results where the acid is added dropwise near the endpoint.

Apparatus and chemicals

- Sodium hydroxide solution
- Hydrochloric acid
- Phenolphthalein indicator
- Dropper
- 25.0 cm^3 pipette and safety pipette filler
- 50.0 cm^3 burette
- Retort stand and burette clamp
- 3 × 250 cm^3 Conical flask
- Deionised water bottle
- White tile

Safety

Wear safety glasses and follow any safety advice given by your teacher.

Practical C8

Determining the reacting volumes of solutions of acid and alkali by titration and determine the concentration of solutions of acid and alkali by titration

Method

1. Rinse the pipette with deionised water and with the sodium hydroxide solution.
2. Using the 25.0 cm^3 pipette and safety pipette filler, place 25.0 cm^3 of sodium hydroxide solution into each of the three conical flasks.
3. Add 3 drops of phenolphthalein indicator to each conical flask.
4. Rinse the burette with deionised water and with the hydrochloric acid.
5. Fill the burette with hydrochloric acid.
6. Carry out a rough titration and two accurate titrations.
7. Use the table to record the results of your titrations. All values should be recorded to 1 decimal place.

	Initial burette reading /cm^3	Final burette reading /cm^3	Titre /cm^3
Rough titration			
First accurate titration			
Second accurate titration			

8. Calculate the average titre and record the observations at the end point below.

Average titre = ______________________________

Observations at end point.

____

____

Practical C8

Determining the reacting volumes of solutions of acid and alkali by titration and determine the concentration of solutions of acid and alkali by titration

Questions (Higher Tier)

The balanced symbol equation for the reaction which occurred during the titration is:

$NaOH + HCl \rightarrow NaCl + H_2O$

1. Calculate the number of moles of hydrochloric acid used in the titration.

2. Calculate the number of moles of sodium hydroxide which reacted with the hydrochloric acid.

3. Calculate the concentration of the sodium hydroxide solution in mol/dm^3 and g/dm^3.

Practical C9

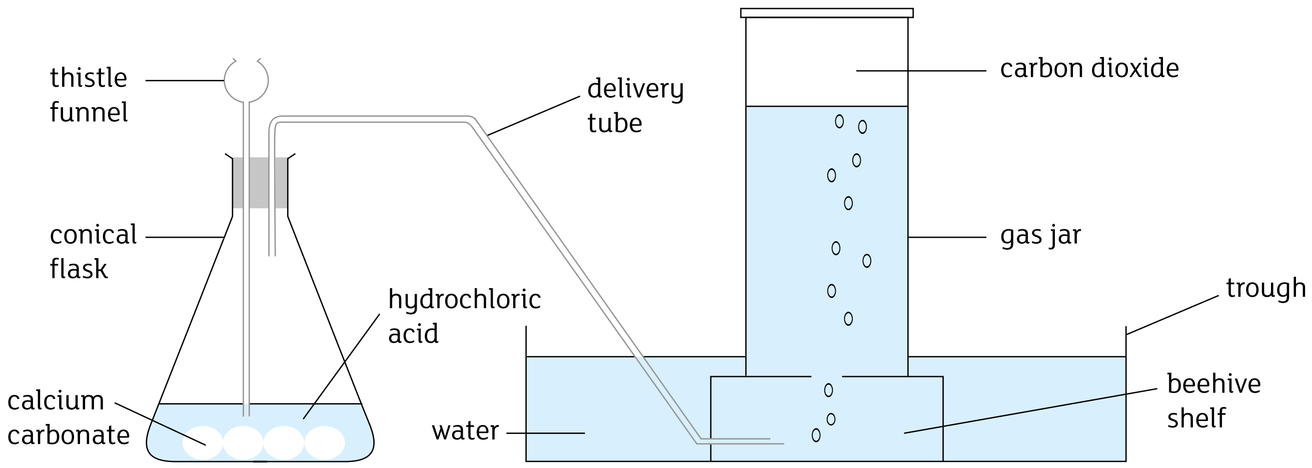
Investigate the preparation, properties, tests and reactions of the gases hydrogen, oxygen and carbon dioxide

Introduction

Hydrogen, oxygen and carbon dioxide can be prepared, on large scale in the laboratory using the apparatus below. These gases are insoluble or have a low solubility in water so they can be collected over water. As the gas is produced the water is displaced and the level in the gas jar moves down so it is easy to see when the gas jar is full of the prepared gas.

In this practical you will prepare some gas jars of carbon dioxide using this apparatus and carry out some tests on the gas. You will also prepare test tubes of oxygen and hydrogen and test for the gases.

Carbon dioxide



Apparatus and Chemicals

- Apparatus shown in the diagram above
- Calcium carbonate
- Hydrochloric acid
- Wooden splint
- Limewater
- Universal indicator solution

Safety

Wear safety glasses and follow any other safety instructions given by your teacher.

Practical C9

Investigate the preparation, properties, tests and reactions of the gases hydrogen, oxygen and carbon dioxide

Method

1. Place 3 g of calcium carbonate into the conical flask and set up the apparatus as shown in the diagram.
2. Have three gas jars filled with water and inverted in trough of water.
3. Slowly pour 50 cm^3 of hydrochloric acid into the thistle funnel, wait 5 seconds and then carefully place the first water filled gas jar on the beehive over the end of the delivery tube.
4. Allow the gas jar to fill with gas, leave the gas jar in the water to retain the gas and replace it with another water filled gas jar.
5. Repeat step 4 until three gas jars of gas have been collected. Remove each gas jars from the water as required for the following tests.

Test 1

To the first gas jar insert a lit splint – record your observations.

Test 2

To the second gas jar add 1 cm^3 of limewater, stopper and shake – record your observations.

Test 3

To the third gas jar add 5 drops of universal indicator and shake – record your observations. Add a little deionised water if no change observed and shake again.

Practical C9

Investigate the preparation, properties, tests and reactions of the gases hydrogen, oxygen and carbon dioxide

Questions

1. Underline the correct answer in each of the following statements.

   Carbon dioxide is:

   - able/not able to support combustion
   - acidic/basic
   - able to react with limewater to produce a soluble/insoluble product

2. Use your experimental results to explain each of your answers to question 1.

   ____

   ____

3. Name the two substances used to produce carbon dioxide in the laboratory and write a balanced symbol equation for the reaction which occurs.

   ____

   ____

Practical C9

Investigate the preparation, properties, tests and reactions of the gases hydrogen, oxygen and carbon dioxide

Hydrogen

Apparatus and chemicals

- Hydrochloric acid
- Zinc
- Wooden splint
- Test tube
- Test tube rack
- Measuring cylinder
- Bunsen burner

Method

1. Measure out 10 cm^3 of hydrochloric acid and place in a test tube.
2. Add a piece of zinc. Wait ten seconds and test the gas by holding a lit split above the level of the liquid in the test tube.
3. Record your observations in the table below.

Appearance of hydrochloric acid	
Appearance of zinc	
Observations during the reaction	
Observations with a lit split	

Questions

1. Name the two chemicals used to prepare hydrogen on a large scale in the laboratory and write a balanced symbol equation for the reaction which occurs.

2. Write a balanced symbol equation for the reaction which occurs during the test for hydrogen.

Practical C9

Investigate the preparation, properties, tests and reactions of the gases hydrogen, oxygen and carbon dioxide

Oxygen

Apparatus and chemicals

- Manganese(IV) oxide
- Hydrogen peroxide solution
- Wooden Splint
- Spatula
- Test tube
- Test tube rack
- 10 cm^3 measuring cylinder
- Bunsen burner

Method

1. Measure out 10 cm^3 of hydrogen peroxide and place in a test tube.
2. Add half a spatula of manganese(IV) oxide. Wait ten seconds and test the gas by holding a glowing split above the level of the liquid in the test tube.
3. Record your observations in the table below.

Appearance of hydrogen peroxide solution	
Appearance of manganese(IV) oxide	
Observations during the reaction	
Observations with a glowing split	

Practical C9

Investigate the preparation, properties, tests and reactions of the gases hydrogen, oxygen and carbon dioxide

Questions

1. You may have noticed tiny bubbles in the hydrogen peroxide solution in the test tube at the start of the experiment. Explain why these bubbles are present.

2. State the purpose of the manganese(IV) oxide.

3. Name the two chemicals used to prepare oxygen on a large scale in the laboratory and write a balanced symbol equation for the reaction which occurs.